

# **STRUCTURAL FLOOR ANALYSIS**

**FINAL (100%) REPORT  
ROOMS 4015, 4015A, 7437 & 8017  
FEDERAL BUILDING  
517 Gold Avenue, SW**

**BPLW Project Number: 91062.009  
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## INTRODUCTION:

The purpose of this report is to explain the investigation, structural floor analysis, and the results of this analysis on the floor slabs in rooms 4015, 4015A, 7437, and 8017 of the Federal Building located at 517 Gold Avenue SW, Albuquerque, New Mexico. These rooms have unusually heavy equipment or furniture that have raised concerns with the building manager about possible floor overloading conditions. Therefore, the building manager requested that the General Services Administration investigate this possibility.

Previous studies of the floor capacity of the Federal Building at 517 Gold have been performed by this office for similar conditions. Rooms 5031, 6433, and 1019 have been analyzed, and a seismic analysis has been performed on the entire building. The previous studies revealed some discrepancies on the original contract documents which raised questions as to the actual compressive strength of the concrete and the tensile strength of the reinforcing. They also revealed that the floor slabs in the building appeared to be experiencing unusually large deflections. Therefore, an additional study was requested by GSA to test the concrete and reinforcing in the floor slabs and to measure the slab deflections. This report is a response to Modification #1 to the scope of work for that study.

This report was requested by the General Services Administration, Design and Construction Division, Fort Worth, Texas as Modification #1 to the material testing and floor analysis requested by delivery order number P-07-92-JU-0133.

**SCOPE:**

The investigation of the floor slabs for the rooms in question included a site visit, a structural analysis of the floor slabs, conclusions from the analysis, and recommendations for alleviating any overloading conditions that may exist.

The purpose of the site visit was to verify the loading conditions given in the scope of work provided by GSA and to note any deviations from the original structural drawings.

The structural analysis was to be based upon the results of the material testing described in the original scope of work. The analysis was to comply with the Equivalent Frame Method of ACI 318-89 and PCA's "Notes on ACI 318-89, Building Code Requirements for Reinforced Concrete."

Conclusions based on the analysis and recommendations for alleviating the overloading conditions are given in this report.

### SITE VISIT:

The site visit was performed by our office on October 9, 1992. The visit was coordinated with the building manager, whose cooperation was greatly appreciated. All three areas in question were investigated, measured and photographed. Scaled drawings of the areas and photographs are given in Appendix A.

### ROOM 4015 & 4015A:

Rooms 4015 & 4015A are filled with bookshelves which exert essentially library type loading on the floor. Most of the bookshelves are completely full of books and some of the remaining floor space is covered with storage boxes - see photos. One of the tenants who worked in an office across the hall from rooms 4015 & 4015A mentioned that until two desks were removed from room 4015A, her desk drawers would not stay closed because of the deflection of the floor in her office. When the desks were removed, it solved the problem. This suggests that the floor slab is deflecting a large amount when a small load is applied.

### ROOM 7437:

Room 7437 is an office on the second floor which houses no unusually heavy loads with the exception of two Spacesaver mobile storage systems. These are essentially large, mobile storage shelves on tracks. The shelves are virtually filled with files. A plan of the room is given in Appendix A and shows the locations of these systems.

### ROOM 8017:

The unusually heavy load in room 8017 is a KARDEX Lektreiver Series 80 electronic file storage cabinet. It contains trays of file drawers on an electronic vertical rotation system. The remainder of the room contains standard office furniture and movable partitions.

### GENERAL:

A cursory walk-through of each of the floors in question was performed. This revealed that there are deflections throughout each of the floors which are sufficiently large to be noticeable without the use of surveying instruments or straight edges. The deflection limitations given in ACI 318-89 are strict enough that no deflections should be noticeable without the use of instruments. This leads one to believe that the actual deflections exceed the serviceability requirements of ACI 318-89. It also suggests that the deflection problem is fairly widespread throughout the building.

## STRUCTURAL ANALYSIS:

### LOADS:

The dead loads generated and listed in Appendix B include the weight of the structure and building materials present. One live load used for the analysis was 80 psf in accordance with the original scope of work requested by GSA. This was the original design live load per the original structural working drawings. Since the Uniform Building Code requires a live load capacity of 50 psf in office spaces and 100 psf in corridors, this loading was also analyzed.

The load for the bookshelves in Rooms 4015 and 4015A was generated in accordance with ASCE 7-88 "Minimum Design Loads for Buildings and Other Structures" which recommends using an assumed density of 65 pcf for the bookshelves and converting this to a uniform floor load. It was assumed that this density accounted for the fact that there could be some empty space between the top of the books and the next shelf.

Since the Spacesaver filing systems in room 7437 are very similar to bookshelves, the density used for these units was the same as for the bookshelves in rooms 4015 and 4015A, 65 pcf. A fully loaded weight was not available from the manufacturer.

The empty weight of the KARDEX filing system in room 8017 was obtained from the manufacturer along with the capacity of the unit. A fully loaded weight was not available from the manufacturer. The unit was assumed to be filled with paper and a weight based on 58 pcf times the capacity plus the weight of the unit was used for the analysis.

### STRUCTURE PROPERTIES:

The geometric configuration of the structure and the floor slab were taken from drawings supplied by GSA. The floor slab is shown on those plans to be an 8" thick two-way reinforced concrete slab system with 4" dropped panels (total thickness of 12") at the columns. The columns are cast-in-place concrete columns on a 25' grid.

### METHOD OF ANALYSIS:

The method of analysis used was the Equivalent Frame method as per ACI 318-89 (see Appendix B for calculations). This was used to calculate the floor slab stiffness at typical sections, dropped panels and at columns. The "equivalent frame" was then modeled on the computer to calculate the stresses in the slab and the columns. The stresses in the members were factored with appropriate ACI load factors in the load combination #1 for negative moment and load combination #2 for positive moment. The other load combinations were for computational conveniences only. The factored

stresses calculated by the computer program were then compared to the ultimate moment capacity of the member.

The shear loads were calculated by hand and compared to the shear capacities of the slabs. The dropped panels contain rebar shearheads originally designed to increase the shear capacity. However, these shearheads can not be included in the calculated shear capacity because they have only one-fourth of the development length required. The shearheads can not be relied upon to carry any shear because they would simply pull out of the concrete when subjected to shear loads.

All of the structural calculations used in the analysis are given in Appendix "B".

## CONCLUSIONS:

### SHEAR:

The floor slabs for this building have dropped panels (8'-4" x 8'-4" x 12" overall thickness) at the columns. These shear panels increase the shear capacity of the slab by increasing the area stressed in shear.

#### ROOMS 4015 & 4015A:

Our analysis showed that the shear capacity of the slab for rooms 4015 & 4015A was not exceeded under code prescribed live loads, dead loads and equipment loads. However, the capacity was exceeded by 7 percent under the 80 psf live load, dead loads, and equipment loads (see Appendix B).

#### ROOM 7437:

The shear capacity of the slab for room 7437 was exceeded by only 2.4 percent under code prescribed live loads, dead loads and equipment loads. The capacity was exceeded by 14 percent under the 80 psf live load, dead loads, and equipment loads (see Appendix B).

#### ROOM 8017:

The shear capacity of the slab for room 8017 was exceeded by only 3.4 percent under code prescribed live loads, dead loads and equipment loads. The capacity was exceeded by 19 percent under the 80 psf live load, dead loads, and equipment loads (see Appendix B).

### MOMENT:

#### ROOMS 4015 & 4015A:

Based on the load capacities calculated for the original scope of work, the floor slab in rooms 4015 & 4015A was overstressed under code prescribed live loads and the existing load of the bookshelves by 9%.

#### ROOM 7437:

Based on the load capacities calculated for the original scope of work, the floor slab for room 7437 was not overloaded under code prescribed live loads of 50 psf live load in the offices and 100 psf live load in the corridors. Under the 80 psf live load given by the original scope of work, the slab in Room 7437 was overstressed by only 0.2%. This is insignificant.

ROOM 8017:

Based on the load capacities calculated for the original scope of work, the floor slab for room 8017 was not overloaded under code prescribed live loads of 50 psf live load in the offices and 100 psf live load in the corridors. Under the 80 psf live load given by the original scope of work, the slab in Room 8017 was overstressed by only 3%.

## RECOMMENDATIONS:

### ROOMS 4015 & 4015A:

Some of the bookshelves in rooms 4015 & 4015A must be removed due to the current overloaded condition of the floor slab. A new bookshelf layout for the two rooms is given in Appendix C. New locations for the bookshelves that are removed from these rooms should be determined by the tenant, as long as the following recommendations are followed:

1. The bookshelves should not be placed in the rooms in this study or adjacent to any of the walls of the rooms in this study.
2. The bookshelves should be placed as close to some columns as possible, excluding the columns bordering rooms 4015 & 4015A.
3. All the bookshelves to be relocated should not be crowded around one column.

### ROOM 7437:

Since the analysis showed that the moment capacities of the slab in room 7437 are not overloaded under code prescribed loads, and overloaded by only 0.2% under a load of 80 psf, it would seem unnecessary to make any changes to the current loading conditions to decrease the moments in the slab.

The shear capacities of the slab is exceeded by only 3% under code prescribed live loads and 18 percent under the 80 psf live load. Based on our observations of the existing loads in these rooms, the live load is closer to 30 psf than the code prescribed live load of 50 psf. Therefore, failure has not occurred. A comprehensive solution to insure the slab could withstand all future loads would be to design and install a tube steel collar to the column below the slab in question. This would be an inexpensive method of increasing the shear capacities of the slabs, and would not necessitate the removal of the equipment from these rooms. This could be incorporated into an overall retrofit of the slabs as mentioned in the report for the original scope of work, as long as the current loading condition does not change until such retrofit occurs.

### ROOM 8017:

Since the analysis showed that the moment capacities of the slab in room 8017 are not overloaded under code prescribed loads, and overloaded by only 3% under a load of 80 psf, it would seem unnecessary to make any changes to the current loading conditions to decrease the moments in the slab.

The shear capacity of the slab is exceeded by only 3.4 percent under code prescribed live loads, dead loads, and equipment loads, and 19 percent under the 80 psf live load, dead loads, and equipment loads. The same recommendations apply to this room as room 7437.

GENERAL:

These recommendations are based on the structural analysis performed by the equivalent frame method given in ACI 318-89 per the scope of work provided by GSA. As mentioned in the report for the original scope of work, however, this method may not be accurate. The large deflections observed and the knowledge of file drawers rolling open due to those deflections causes great concern. Engineering judgement insists that at least a partial failure of the floor slabs has occurred. Recommendations regarding the partial failure are given in the report that responds to the original scope of work.